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ABSTRACT

Information on research activity at Arizona's three universities (Arizona State University, University of Arizona, and Northern Arizona University) is presented as one of the working papers in the final report of the Arizona Board of Regents' Task Force on Excellence, Efficiency and Competitiveness. For both faculty and students, the presence of research activity and the existence of research requirements are essential to the quality and credibility of a graduate degree program. To regard research activity as an expensive luxury or a detriment to instruction conveys a misunderstanding of the university in promoting and producing knowledge and of the economic potentials of university initiated research. Topics addressed are: the breadth of university research; status of research at each university; relationship of research to instruction--the faculty and administrative view; research incentives and disincentives; research recognition and competitiveness; and increasing non-state funding for research. Recommendations include the following: the Regents should consider starting an eminent scholars' program to attract highly productive researchers in areas of strategic importance; each institution should listen to what faculty cite as research disincentives and seek remedies insofar as possible; and the Regents and the executive and legislative branches of the state should increase support of basic and applied research, scholarship, and creative activity in Arizona's three universities. Two appendices provide a copy of the questionnaire sent to graduate deans and vice presidents for research and a copy of the questionnaire sent to selected department heads. (SM)

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# THE STATUS OF RESEARCH ACTIVITY AT ARIZONA'S UNIVERSITIES: A WORKING PAPER

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MARVIN FISHER

Each of Arizona's universities cites research and graduate education as a part of its institutional mission, yet there are important differences in their historical development and their current status. In the case of the two larger universities, there are also some surprising similarities. This inquiry into related areas of research and graduate education recognizes no particular academic virtue in having the three universities move to a single institutional profile. Rather economy and efficiency justify a reasonable concern with duplication, especially in areas that require expensive equipment or extensive facilities. When universities serve large student populations and are called upon to fulfill the research and educational needs important to existing industry and essential to attracting new industry, reasoned judgment recognizes the inevitable duplication of some functions and facilities. Large universities, sometimes termed multiversities, need not be identical; neither can they be too dissimilar. It might seem frivolous to use Fiesta Mall in Mesa and Christown and Metrocenter in Phoenix as examples. They are certainly not identical but many functions and facilities are very similar, and the population served by each would be greatly disappointed if they could not count on the similarities.

It would be futile and perhaps foolish to try to curb ASU's growing research involvements and accomplishments or NAU's developing research emphases to gain short-sighted or dubious economies. At this point in the twentieth century the needs and resources of the State of Arizona do not justify a scenario reminiscent of nineteenth-century melodrama in which a prudent family has to decide which of their deserving children can be sent to college.

Of course the modern university is neither a merchandising organization nor a for-profit enterprise and the State of Arizona has had enough of melodrama, but the analogy can still be illuminating, especially in view of the economic and chronological diversity of the student population in the major metropolitan centers. The universities serve a clientele much broader and less mobile than the 18 to 24 year old resident student who can live wherever he or she wants to enroll. Maintaining minority access to undergraduate programs and providing post-graduate programs for working professionals are but two examples of important public policy concerns over educational opportunity concerns which relate to both social stability and economic development.

Dr. Marvin Fisher, a specialist in American literature and cultural history, has been a member of ASU's English Department for 30 years, including six as department head. He has taught at three other American universities and three foreign ones. Among his several books is one on the beginnings of American industrialization and its impact on the economy, society, and the imagination.

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Some graduate degree programs can be pursued at any of the universities; some broad areas of faculty research are pursued at all of the universities. For both faculty and students, the presence of research activity and the existence of research requirements are essential to the quality and credibility of a graduate degree program. Even those examples of research so specialized that they seem to lack a teaching component may reflect very favorably on the institution, the specific program, and the researchers. To regard research activity as an expensive luxury or a detriment to instruction conveys a misunderstanding of the university in promoting and producing knowledge and a short-sighted view of the economic potentialities of university initiated and conducted research, a subject addressed in an accompanying paper.

## THE BREADTH OF UNIVERSITY RESEARCH

As a term, "research" has a relatively narrow denotation in the popular mind and a much broader application in academic parlance. By and large the popular understanding of the term draws upon the laboratory based nature of the physical sciences, engineering, and medicine. It starts with a problem, relies on precise empirical procedures, and aims at a solution which ostensibly has tangible advantages or benefits. The public does not know that much of university-conducted scientific research, and what most distinguishes university research from what goes on at IBM or Pfizer Pharmaceuticals, is actually basic research aimed at increasing knowledge rather than providing practical benefits. Basic research may stimulate subsequent unforeseen applications, but potential applications ought not be a criterion for supporting basic research.

The social sciences can also conduct both basic and applied research, even though the methodology may not be as precise and the conclusions more debatable. Historical research moves away from this pattern toward what might be called scholarship. The process of informed inquiry into letters, documents, and records can illuminate past events and uncover unsuspected relationships. It can add to knowledge and deepen understanding, but it lays less claim to tangible utility. The investigator's informed judgment and access to sources are more important than precise measurement or controlled conditions. Literary studies (which can proceed from a historical, political, psychological, or religious perspective, which can embody linguistic or rhetorical methods of analysis, or which can emphasize interpretation, explication, or theory) move even further from the commonly understood pattern of research.

These studies, whether they stress literary history, aesthetic discrimination, cultural integrity, or human values, are aimed at other literary scholars and teachers of literature who can use them for reinforcement or refutation in their own writings or incorporate the new information and insights into their own teaching. Clearly these are much less tangible economic benefits than those that might be derived from research into a potential new energy source or a potentially more efficient means of toxic waste disposal. For fine arts faculty, quality and frequency of performance, exhibition, or publication of creative writing are better gauges of scholarly activity. All of these diverse forms of professional activity, in addition to the major responsibility for instruction, are part of what a comprehensive university expects of its faculty. They are also the

basis for evaluating the quality of the institution and determining its competitive reputation.

American universities are unique among the institutions of higher education in the world. They are more comprehensive in what they offer and more extensive in what they attempt. Even in the most advanced of other societies one cannot find a college of engineering, law, medicine, business, and fine arts under a single institutional umbrella. And the college of liberal arts and sciences probably does not exist outside the American university. The task of general education precedes university entrance, and foreign universities offer more focused professional preparation. Furthermore, state-supported research institutes devoted to specific scientific or engineering pursuits frequently exist outside the university structure. The appropriate professional activities of faculty at a conservatory of music do not have to conform to those characteristic of an institute of economic research, a school of civil engineering or one of social work. In the U.S., however, major universities now designate themselves as "research universities," and the designation itself leads to internal and external expectations of cross-disciplinary uniformity or conformity which cannot exist. Or it leads to greater internal or external esteem for those whose professional research follows scientific procedures and fulfills pragmatic expectations. The breadth and comprehensiveness of the large American universities require appropriately broad standards for evaluating and esteeming the diverse professional activities that correspond to but are not quite covered by the term "research." We must remember that not even the leading research universities can live by bread alone. But it certainly helps.

## STATUS OF RESEARCH AT EACH UNIVERSITY

As one of only 70 U.S. universities classified as Research I institutions by the Carnegie Foundation, the University of Arizona draws upon its historical role and its present character to attract federal funding for research. The Carnegie Foundation classification includes private and public institutions and utilizes both annual totals of federal research and development funds and the presence of doctoral programs in major, specified areas. In the NSF rankings, based solely on an annual tally of federal research and development funds, the UA was 20th among all American universities. Since 1890, when the first such funds were received for its agricultural experiment station, UA has broadened its research activities so that for the present and future, in the words of Dr. Laurel Wilkening, former UA Vice President for Research, "sponsored and unsponsored research must remain a driving force of the University's mission." These research activities are essential (1) to the expansion and promotion of knowledge, (2) the education of students at the graduate and undergraduate levels, (3) the continuing ability of the University to attract creative and productive faculty and the external support they need, and (4) the economic growth and competitive position of Arizona and the nation.

For FY 1987 UA received $154 million to support research activities. External agencies provided $118 million of this total sum for specific research projects. The total also included state allocations for Organized Research Units and indirect cost funds recovered on research grants and contracts. State

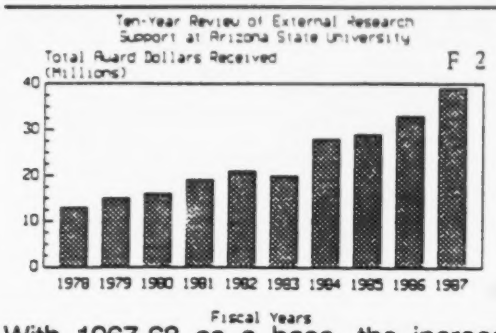
investment for salaries, operations, travel, and equipment for Organized Research Units was $17 million.[1] Indirect cost recovery on sponsored projects was $19 million, invested in research enhancement and support services. In percentage terms external agencies (federal and state, industrial and corporate, institutions and foundations) provided nearly 66% of the total research outlay, indirect cost receipts provided just over 12%, and state funding provided 22%. Thus externally sponsored projects and related indirect costs provided 78% of the research support in 1986-87.

The record of increase in funding for Organized Research for FY 1977 compared to 1987 is a healthy 294%. If FY 1967 is used as a base for a 20 year perspective, the increase in external support for Organized Research is 1204%, a very substantial figure even if adjusted for inflation. Having achieved acknowledged status as "a major comprehensive research university" the UA has maintained the kind of growth rate which, in the words of the ABOR Mission and Scope Statements, makes it "competitive with the best public universities in the nation." (Figure 1). The institutions ahead of UA in the Carnegie Foundation classification, however, include the best in the land. Remaining competitive in such company will continue to require substantial commitment of state resources.

The faculty is up to the challenge as evidenced by UA's recent selection for both a NASA Research and Technology Center and an NSF Biology Center, in the face of very stiff competition nationally.

The historical roles of Arizona State University and Northern Arizona University in regard to sponsored research differ from that of UA, but in each instance important changes are evident. ASU received slightly over $39 million during FY 1987 in awards for research and academic projects, and expenditures totaled $37 million. This figure includes a construction grant of $5 million from the Department of Energy. The total elevates ASU for the first time to the level of Research II institutions. Awards from the federal government reached $28 million, a figure which puts ASU close to the $33.5 million threshold for determining Research I institutions. But the remaining step may prove as steep as its past progress. Passing the next 20 institutions will require more effort and focused commitment of resources than it took to pass the 50 just overtaken.

State investment in Organized Research at ASU was nearly $8 million, and indirect cost recovery was nearly $6 million. In percentage terms external agencies provided approximately 62% of the outlay for research, state funding almost 22%, and indirect costs approximately 16%. The rate of increase for research funding over the past 10 and 20 years is both revealing and impressive. With FY 1977 as a basis for comparison, ASU's increase in funding for Organized Research is 328% (Figure 2).




With 1967-68 as a base, the increase approaches 3400% for the areas of science and engineering. This change in research activity Institutional RAI and R&D Expenditure Rankings 1980 and 1985 indicates a rate of progress unlikely to have been matched by any other American university. On the other hand, one can argue reasonably that a 20 year comparison is meaningless for ASU, which began its determined and competitive growth as a research university in the past decade. Within that decade, however, the growth rate substantiates ASU's aggressive fulfillment of its Mission and Scope directive that it pursue its "development as a major research university" and "become competitive with the best public universities in the nation."

Between 1980 and 1985, ASU progressed from 149th place to 94th nationally in federal R & D funds, the second highest improvement rate in the nation, according to National Science Foundation compilations. Since reliance on federal R & D funds is not only indicative of activity but may also be simplistic or incomplete, two UA specialists in higher education research developed a multivariate measure of university research activity. Using 14 variables, they developed a more complete Research Activity Index to rank the top 200 research universities in 1980 and 1985.[2]

Based on their RAI, ASU made the greatest progress from 104th place in 1980 to 63rd in 1985. The status of UA, based on the same two modes of indexing, has remained steady and constant. Its rank as determined by federal R & D funds rose from 24th in 1980 to 23rd in 1985. By the more complex RAI rankings, UA fell from 23rd in 1980 to 25th in 1985. (Table 1). But as mentioned earlier, the resources of UA's competitors make them more formidable than the institutions that ASU has passed in this five year period.

Although the total invested in ASU research is a fraction of what UA received, one must remember the high-ticket units at UA without counterparts at ASU, for example the College of Medicine with $42 million in external support, the College of Agriculture with $9 million, the Optical Sciences Center with $10 million, and the Steward Observatory with $15 million. These four units alone account for half of the UA research funding and none is duplicated at ASU or NAU. And with more than half (54%) of the nation's total R & D awards going to the life sciences and with less than 10% of ASU's sponsored research occurring in the life and health sciences, ASU faces a serious constraint. To continue its momentum and fulfill its stated ambition to pass the Research I threshold, it must plan effectively to strengthen research programs in the life sciences and improve its ability to attract external research funding.

Research at all three universities is diffused through the disciplines, though R & D funds predominantly support science and engineering projects. With 45.4% of its R & D awards in the life sciences (including medicine and agriculture) UA is advantageously positioned to compete in the areas of greatest funding, more so than ASU,

TABLE 1

**Institutional RAI and R&D Expenditure Rankings, 1980 and 1985**

| Institution Name | RAI RANK 1980 | RAI Rank 1985 | R&D Exp. Rank 1980 | R&D Exp. Rank 1985 |
|---|---|---|---|---|
| HARVARD UNIVERSITY | 1 | 1 | 11 | 14 |
| UNIV OF WIS-MADISON | 2 | 2 | 3 | 3 |
| MASS INST OF TECHNOLOGY | 3 | 5 | 2 | 2 |
| UNIVERSITY OF MINNESOTA | 4 | 9 | 5 | 6 |
| UNIV OF CAL BERKELEY | 5 | 7 | 13 | 9 |
| UNIVERSITY OF MICHIGAN | 6 | 3 | 8 | 8 |
| UNIV OF CAL LOS ANGELES | 7 | 6 | 14 | 10 |
| JOHNS HOPKINS UNIVERSITY | 8 | 10 | 1 | 1 |
| JOHNS HOPKINS U. W/O APL | | 19 | | 21 |
| CORNELL UNIVERSITY | 9 | 4 | 9 | 4 |
| OHIO STATE UNIVERSITY | 10 | 13 | 23 | 24 |
| UNIVERSITY OF WASHINGTON | 11 | 11 | 7 | 7 |
| STANFORD UNIVERSITY | 12 | 8 | 6 | 5 |
| COLUMBIA UNIV MAIN DIV | 13 | 16 | 10 | 15 |
| UNIV OF ILL URBANA | 14 | 12 | 15 | 13 |
| UNIV OF TEXAS AT AUSTIN | 15 | 14 | 16 | 18 |
| UNIV OF SOUTHERN CAL | 16 | 15 | 17 | 25 |
| YALE UNIVERSITY | 17 | 21 | 22 | 22 |
| UNIV OF PENNSYLVANIA | 18 | 18 | 12 | 17 |
| UNIVERSITY OF FLORIDA | 19 | 26 | 32 | 29 |
| MICHIGAN STATE UNIV | 20 | 31 | 19 | 28 |
| PENNSYLVANIA STATE UNIV | 21 | 22 | 20 | 20 |
| PURDUE UNIVERSITY | 22 | 29 | 28 | 32 |
| **UNIVERSITY OF ARIZONA | 23 | 25 | 24 | 23 |
| UNIV OF CAL SAN DIEGO | 24 | 24 | 4 | 12 |
| TEXAS A & M UNIVERSITY | 25 | 17 | 21 | 11 |
| NEW YORK UNIVERSITY | 26 | 28 | 31 | 34 |
| UNIV OF CAL DAVIS | 27 | 23 | 25 | 19 |
| LOUISIANA STATE UNIV | 28 | 27 | 35 | 31 |
| INDIANA UNIVERSITY | 29 | 30 | 63 | 57 |
| UNIVERSITY OF ROCHESTER | 30 | 45 | 26 | 33 |
| UNIV OF CAL SAN FRANCISCO | 31 | 20 | 18 | 16 |
| WASHINGTON UNIVERSITY | 32 | 39 | 29 | 36 |
| UNIVERSITY OF IOWA | 33 | 38 | 37 | 47 |
| UNIVERSITY OF COLORADO | 34 | 37 | 27 | 27 |
| UNIVERSITY OF CHICAGO | 35 | 35 | 30 | 37 |
| UNIVERSITY OF GEORGIA | 36 | 44 | 34 | 35 |
| UNIV OF NC AT CHAPEL HILL | 37 | 36 | 51 | 42 |
| IOWA ST U OF SCI & TECH | 38 | 47 | 36 | 44 |
| UNIVERSITY OF PITTSBURGH | 39 | 33 | 60 | 48 |
| UNIV OF MD COLLEGE PARK | 40 | 32 | 49 | 26 |
| RUTGERS THE ST UNIV OF NJ | 41 | 41 | 55 | 52 |
| UNIVERSITY OF CONNECTICUT | 42 | 19 | 39 | 38 |

TABLE 1

**Institutional RAI and R&D Expenditure Rankings, 1980 and 1985**

| Institution Name | RAI RANK 1980 | RAI Rank 1985 | R&D Exp. Rank 1980 | R&D Exp. Rank 1985 |
|---|---|---|---|---|
| NORTHWESTERN UNIVERSITY | 43 | 40 | 43 | 41 |
| DUKE UNIVERSITY | 44 | 48 | 50 | 43 |
| UNIVERSITY OF UTAH | 45 | 56 | 54 | 58 |
| CASE WESTERN RESERVE UNIV | 46 | 65 | 46 | 61 |
| N C STATE UNIV AT RALEIGH | 47 | 42 | 41 | 40 |
| GEORGIA INSTITUTE OF TECH | 48 | 53 | 33 | 30 |
| WASHINGTON STATE UNIV | 49 | 59 | 61 | 72 |
| BOSTON UNIVERSITY | 50 | 46 | 78 | 77 |
| VA POLYTECH INST & ST U | 51 | 51 | 58 | 50 |
| UNIVERSITY OF KENTUCKY | 52 | 50 | 64 | 67 |
| UNIVERSITY OF CINCINNATI | 53 | 60 | 68 | 79 |
| PRINCETON UNIVERSITY | 54 | 52 | 69 | 72 |
| OREGON STATE UNIVERSITY | 55 | 55 | 38 | 39 |
| BAYLOR COL OF MEDICINE | 56 | 77 | 53 | 49 |
| UNIV OF HAWAII-MANOA | 57 | 69 | 48 | 59 |
| UNIVERSITY OF KANSAS | 58 | 57 | 88 | 102 |
| SUNY AT STONY BROOK | 59 | 61 | 74 | 66 |
| UNIV OF MISSOURI COLUMBIA | 60 | 58 | 57 | 62 |
| UNIVERSITY OF VIRGINIA | 61 | 49 | 71 | 60 |
| SUNY AT BUFFALO | 62 | 34 | 80 | 55 |
| UNIV OF NEBRASKA-LINCOLN | 63 | 75 | 59 | 65 |
| TEMPLE UNIVERSITY | 64 | 78 | 91 | 103 |
| CARNEGIE-MELLON UNIV | 65 | 54 | 65 | 51 |
| UNIVERSITY OF MIAMI | 66 | 64 | 45 | 54 |
| WAYNE STATE UNIVERSITY | 67 | 74 | 85 | 99 |
| FLORIDA STATE UNIVERSITY | 68 | 82 | 83 | 88 |
| COLORADO STATE UNIVERSITY | 69 | 72 | 47 | 76 |
| VANDERBILT UNIVERSITY | 70 | 70 | 86 | 89 |
| YESHIVA UNIVERSITY | 71 | 81 | 42 | 45 |
| CALIFORNIA INST OF TECH | 72 | 71 | 40 | 46 |
| KANS ST U - AG & APP SCI | 73 | 87 | 70 | 85 |
| UNIV ALABAMA BIRMINGHAM | 74 | 88 | 62 | 68 |
| UNIV OF MASS AT AMHERST | 75 | 76 | 99 | 83 |
| U TENNESSEE KNOXVILLE | 76 | 89 | 116 | 132 |
| U OF HOUSTON UNIV PARK | 77 | 95 | 117 | 134 |
| HOWARD UNIVERSITY | 78 | 86 | 122 | 146 |
| UNIV OF CAL IRVINE | 79 | 66 | 82 | 74 |
| UNIV OF CAL SANTA BARBARA | 80 | 85 | 110 | 92 |
| UNIV OF SOUTH CAROLINA | 81 | 93 | 153 | 114 |
| UNIVERSITY OF NEW MEXICO | 82 | 73 | 79 | 73 |
| UNIV OF CAL RIVERSIDE | 83 | 91 | 76 | 75 |
| WEST VIRGINIA UNIVERSITY | 84 | 110 | 95 | 152 |
| OKLAHOMA STATE UNIV | 85 | 84 | 81 | 63 |
| GEORGETOWN UNIVERSITY | 86 | 83 | 96 | 100 |
| UNIV OF ILL CHICAGO | 87 | 62 | 135 | 64 |
| U TEX MED BRNCH GALVESTON | 88 | 114 | 101 | 110 |
| UNIVERSITY OF OKLAHOMA | 89 | 67 | 102 | 80 |

TABLE 1

**Institutional RAI and R&D Expenditure Rankings, 1980 and 1985**

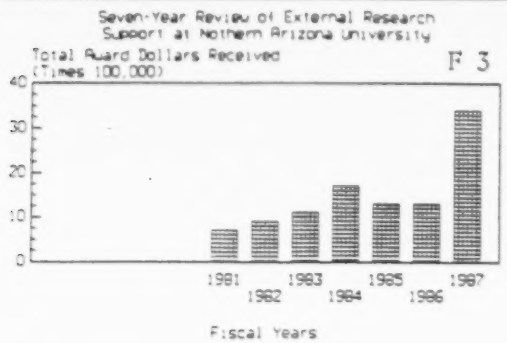
| Institution Name | RAI RANK 1980 | RAI Rank 1985 | R&D Exp. Rank 1980 | R&D Exp. Rank 1985 |
|---|---|---|---|---|
| SYRACUSE UNIVERSITY | 90 | 80 | 100 | 107 |
| ROCKEFELLER UNIVERSITY | 91 | 68 | 52 | 53 |
| SOUTHERN ILL U-CARBONDALE | 92 | 94 | 154 | 122 |
| UNIVERSITY OF DELAWARE | 93 | 102 | 98 | 108 |
| U TEXAS SYSTEM CANCER CTR | 94 | 90 | 56 | 56 |
| CUNY MT SINAI SCH OF MED | 95 | 106 | 72 | 82 |
| MISSISSIPPI STATE UNIV | 96 | 103 | 67 | 81 |
| U TEX HLTH SCI CTR DALLAS | 97 | 79 | 73 | 69 |
| GEORGE WASHINGTON UNIV | 98 | 101 | 90 | 128 |
| UNIV OF ARK FAYETTEVILLE | 99 | 104 | 84 | 106 |
| AUBURN UNIVERSITY | 100 | 92 | 87 | 86 |
| BRIGHAM YOUNG UNIVERSITY | 101 | 116 | 181 | 165 |
| TEXAS TECH UNIVERSITY | 102 | 113 | 113 | 121 |
| UNIV OF ALASKA FAIRBANKS | 103 | 147 | 44 | 95 |
| *ARIZONA STATE UNIVERSITY | 104 | 63 | 149 | 94 |
| U TEX HLTH SCI CTR S ANTON | 105 | 103 | 109 | 93 |
| CLEMSON UNIVERSITY | 106 | 99 | 92 | 90 |
| EMORY UNIVERSITY | 107 | 100 | 103 | 91 |
| UTAH STATE UNIVERSITY | 108 | 117 | 77 | 84 |
| UNIV OF MED & DENT OF NJ | 109 | 111 | 119 | 109 |

Devised and compiled by Drs. Larry L. Leslie and Kenneth G. Brown, UA

which attracts 36% of its R & D funding for engineering projects. Engineering at UA drew 8.2% of the R & D funds in the past fiscal year, and engineering at NAU drew 3%. Strong life sciences and forestry programs at NAU accounted for 57.8% of external R & D funding, far ahead of any other academic division. The plight of the arts and humanities is apparent when one considers that science, technology, social science and education attract more than 97% of the research funding at ASU and more than 98% at UA. Internal grants-in-aid and awards of released time can do much to remedy the imbalance, even though some researchers may question the use of indirect cost recovery funds for such a purpose.

If a 20 year perspective on sponsored research at ASU carries us back to a gestation stage, a 10 year perspective at NAU has the same result. The need for a concerted emphasis on externally funded research was articulated in the 1970's at ASU and expressed in the 1980's at NAU. Even the mission and scope statement propounded for NAU in 1982-83 refers to research as a limited and subordinate part of the university role. In the words of Dr. Henry O. Hooper, Associate Vice President for Academic Affairs, Research and Graduate Studies, "We do not plan to become a 'research university'. Our primary mission is undergraduate instruction with graduate instruction in selected areas. However, there is a strong belief that research activities form an integral part of our instructional program... We believe that faculty must be involved in their discipline as scholars if they are to be excellent teachers." This belief is embodied in a NAU emphasis on early involvement of students in research, on a research requirement for the baccalaureate degree in several science programs, and on learning as an active rather than a passive process. These admirable aims of integrating research and instruction seem both sound and modest for NAU when compared to the more visible attempts of UA and ASU to pursue high technology research so complex and expensive that it requires elaborate federal, state, city, corporate, industrial, and university cooperation. NAU research has a positive effect on the university's predominantly undergraduate educational mission; UA and ASU research has its greatest impact on graduate education and has the additional goal of stimulating economic growth and development.

In the context of NAU's distinct character and circumstances, the development of research activities during the past seven years is admirable and impressive. From 1981 on the rate of growth has accelerated steadily, with an especially rapid increase in FY 1987. For the last complete fiscal year, NAU received $5.6 million to support research activities. State investment in Organized Research constituted 33% and indirect cost recovery 6.23%. From FY 1981 to 1987 research funding at NAU rose 209%; but the rise from 1986 to 1987 alone was 102%. Even more startling is the one-year increase in research awards received from external sources ($3.39 million in 1987, $1.33 million in 1986) a percentage increase of 156%. Such a sharp increase, due mainly to major awards in Biology and Geology, cannot be expected to continue but anything short of a drastic drop would actually contribute to what should be a decade of steady growth in research funding at NAU. (Figure 3).




Because of its location, NAU has emphasized research in biology, geology, anthropology, and forestry. It has sought and received state support for the Bilby Research Center, a facility fostering interdisciplinary research on problems of an ecological and environmental nature. Another recent addition is the Division of Educational Research, which should add measurably to the activities of the Center for Excellence in Education and strengthen NAU's role of cultural and educational service to American Indians, just as the Center for American Indian Economic Development advances their economic interests. The program in Hotel and Restaurant Management has also added a research institute. Several different departments participate in the Institute for Human Development. Older centers exist for Business and Economic Research, for Vocational Education, and for the study of several geological and environmental phenomena. NAU has identified its regional needs and resources, established areas of strength appropriate to these needs, and recognized the role of research in its continuing institutional development. Lacking the historical emphasis on research that pertains at UA, lacking the burden or blessing of ASU's metropolitan location and urban mission, NAU has not pressed research aspirations as strongly as the two larger institutions. In these less harried circumstances, NAU can boast the most direct justification for and the most conscious integration of research in its undergraduate as well as its graduate programs.

## RELATIONSHIP OF RESEARCH TO INSTRUCTION: THE FACULTY AND ADMINISTRATIVE VIEW

To a remarkable degree the heads of academic units and the central research administrators of all three universities, who responded to detailed questionnaires, concur on the necessity of a strong research requirement for most graduate degree programs, the only exception being the permissibility of an appropriate applied project for some advanced degrees in professional or vocational programs. To an only slightly lesser degree, they also stress the desirability of undergraduates encountering research-active faculty members and of gaining first-hand research experience themselves. In research universities many heads of academic units are faculty members appointed for limited terms with the expectation of returning to faculty status. Views reflected in their replies to the questionnaire tend to merge the administration perspective and that of the faculty.

Deans, department heads, research vice presidents, and many faculty respondents insist that research and graduate education are inseparable; some take the relationship a step further and call it "synergistic," meaning not merely a cooperative or reciprocal relationship but one where the result is greater than the sum of its parts. When any existing graduate program is up for review, the evaluators first examine the research records of participating faculty,

and at a later stage they look also at the research records of the programs' graduates. When a new program has been proposed, the research records of participating faculty again offer an index to the program's viability. Other criteria also apply and research accomplishments alone do not determine the decision, but no new program can expect approval without the convincing reinforcement of faculty research and scholarship.

Faculty members at all three institutions believe that research invigorates teaching, but interviews with numerous focus groups representing a cross-section of the faculty produced some institutionally distinct attitudes and opinions. At UA, where the emphasis on research has had greater duration and discernibility, the faculty seemed most skeptical about institutional commitment to improving the quality of undergraduate teaching and most dubious about genuine consideration of teaching performance as a factor in promotion and tenure decisions or in merit evaluations. Through the Faculty Senate they have successfully pressed for greater attention to teaching performance as a factor in promotion, tenure, and merit determinations.

By and large, ASU faculty seemed most optimistic about their own and their institution's efforts to balance teaching and research activities in a pedagogically and professionally beneficial combination. They had fewer qualms about the process of evaluating teaching and more faith in departmental and institutional intentions to reward good teaching as well as research productivity. Although they considered evidence of significant research and scholarship as well as teaching ability essential to promotion and tenure, they would also favor teaching assignments and merit evaluations keyed to an individual's specific strengths rather than to a uniform pattern, but subscribed generally to the belief that the most effective teachers were likely to be active in research and scholarship as well.

At NAU the agreement between administrators and department heads about the value of and need for research stands in greatest contrast to faculty views. Faculty repeatedly reported mixed signals about what was required for advancement and they were highly critical of what they perceived as administrative redefinition of the institutional character and mission away from the traditional concern for the quality of undergraduate education and attention to student needs and toward the greater impersonality and different pressures of the research university. They felt that their circumstances and principles of institutional ethics and equity called for parallel routes to professional advancement, flexible criteria that could reward strong contributions to teaching (as fulfillment of a facet of the institutional mission) as well as research productivity. What has come to be called "the two cultures," not C.P. Snow's dichotomy of scientists and humanists, but the protagonists and antagonists of contemporary academe was most apparent at NAU. But what was also apparent was a genuine concern for the students whom the institution served, and this concern provoked the proposition that the most meaningful measure of faculty research and scholarship was not in the number of publications and grants but in the impact that faculty research interests had on students. When this proposition was accompanied by an account of seven NAU undergraduates and one graduate student who presented papers at a

regional meeting of the American Chemical Society, it seemed especially persuasive. What it proves, albeit by a parallel route, is the insistence that teaching and research are aspects of a single activity, separable aspects in many cases but inseparable in those highly desirable instances of genuine synergy.

## RESEARCH INCENTIVES AND DISINCENTIVES

At NAU, faculty cited heavy teaching loads and inadequate staff support as disincentives to research. At ASU, they felt teaching loads and flexible assignments encouraged research activity, but support staff remained a critical concern. Those in areas where library resources are important to research and scholarship had additional complaints. At ASU graduate students, who do not have the long-term loan privileges that faculty have, were critical of the hours of library services, but ASU and UA faculty felt that they were generally well served. At NAU, however, there are difficulties. One NAU faculty member, a publishing scholar in a humanities area minced no words: "The library sucks. It is deficient in its primary holdings, and wholly inadequate in secondary resources. It has only 1/3 the periodicals necessary for a graduate program and it is barely adequate for undergraduate instruction. It has inadequate space, inadequate staff, and inadequate hours. I have to go to Tempe or Tucson several times a year to find what I need." This is a harsher opinion than was recorded in our survey of university services, but even there NAU library services ranked significantly lower than those at UA and ASU. Such an opinion suggests that more attention to and reinforcement of the academic infrastructure might be required at NAU before some current institutional ambitions can be appropriately fulfilled.

At all three institutions most faculty valued locally administered grants-in-aid of research, especially when they were available on a timely basis, and when they offered research support for less generously subsidized humanities and social science areas. Progress seems most marked at ASU and NAU for such "forgotten" fields. But in those science areas, most of them at UA, where research and equipment costs were astronomical, such aid was viewed as so limited as to be insignificant. These areas called for more state provided seed money, matching funds to reinforce grant applications, more adequate laboratory space, more up-to-date equipment, and start-up costs for new faculty, which ranged from $150,000 to $250,000 for each new hire. Science faculty and administrators at ASU echoed these complaints about a critical space shortage and lack of capital funds for new equipment. ASU's Distinguished Research Award (by means of which recipients are released from classroom commitments but retain responsibility for directing graduate students, while the Graduate College foots the bill for instructional replacement) has broad support and seems well worth consideration elsewhere. As a jury, faculty and department heads remained non-committal on the newly designated Regents' Professorships; they wanted to see how the process worked and what results it produced before they offered a judgment. ASU faculty were less hesitant about judging the means by which mini-grants ($500 or less) could be applied for and awarded. The time expended on the application (10 copies) and the time expended by the sizable committee judging the applications seemed disproportionate to the amounts

involved. What was intended as an available aid could function as a bureaucratic disincentive.

Maintaining the established excellence of an outstanding unit such as UA's Optical Sciences Center or Lunar and Planetary Laboratory may require increased state investment even though external funding might have risen from $5 million to more than $10 million in the past five years. It could be penny-wise and pound-foolish to expect a major scientific research operation with such inordinately high start-up costs for new research personnel to depend on external sources for 90% of its costs (including salaries for some tenured faculty). Efficiency requires recognition of the manifold economic impacts of state investment in such conspicuously successful units, and recognition of the inappropriateness of requiring major scientists to go hat in hand to corporate sponsors. Industrial cooperation can be an incentive; academic mendicancy a major disincentive.

At all three institutions faculty and department heads were convinced of the need to support faculty travel to professional conferences to report the results of their research and scholarship, to learn what others are doing elsewhere, and to cultivate the professional contacts important to the competitive reputation of their institutions and the professional future of their graduates. Their reports, however, reveal that within a single institution, the amounts allocated to specific academic units in their operating budgets may on a per capita basis vary by tenfold. Dissatisfaction in this area was rife, even in those areas where the bulk of travel costs were covered by grants, and those faculty who cited the discrepancies between the way travel for administrative purposes is reimbursed (travel, meals, lodging, incidentals) and the way that travel for professional academic purposes is supported (cheapest coach fare, no per diem, no registration costs) could be incited to palace revolt or class action suit.

## RESEARCH RECOGNITION AND COMPETITIVENESS

The standard measure of academic research and scholarship is through peer review and evaluation. The most substantive forms of research funding and of scholarly publication involve peer review prior to research award or to publication acceptance. Post-publication reviews also affect the author's reputation and that of the employing institution. The amount of research funding is an appropriate measure for those fields where funding is available, and requests for such funding at the national level have become extremely competitive. The majority of federal agencies use the peer review process, and when these panels of experts recommend an award, their recommendation indicates that the technical content is outstanding and the proposal worthy of support.

Both federal agencies and private foundations sponsor award programs for outstanding researchers. The presence of a Nobel Prize winner or of recipients of Pulitzer, MacArthur, Guggenheim, or Kellogg awards reflects simultaneously on the individual, the academic department, and the employing institution. Receipt of such an award alerts talent hunters at distant universities and often sets off a bidding war for the recipient's services that enhances his or her competitive position and tests the employing institution's competitive resolve. Lesser awards, if determined

through national competition, can also add to institutional reputation and strengthen competitive position. The number of NSF Presidential Young Investigators' Awards reflects the success of recent recruiting efforts in major scientific fields and the degree of stimulation and encouragement in the institutional atmosphere. Fulbright-Hays research awards and university lectureships, also awarded in national competition, are an index to the global and intercultural interests of the faculty as well as to their professional standing.

One Nobel Prize winner (Physics) is currently on the UA faculty, along with two Pulitzer Prize winners (Fiction and Journalism). Two faculty members have received MacArthur Foundation awards. Since 1984 UA faculty have garnered an average of 10 Fulbright-Hays awards each year, and a total of 12 Guggenheim fellowships, 20 Sloan Foundation awards, 13 National Academy of Science awards and 7 National Institute of Health Career Development Awards. Ten science and engineering faculty have received National Science Foundation Presidential Young Investigators Awards. Several young artists and writers have received National Endowment for the Arts awards and Career Development awards in the sciences. Three more established faculty members have received Humboldt Foundation Senior Scientist awards and another a Senior Fellowship from the National Endowment for the Humanities. Three have received Kellogg Foundation Fellowships, and one a National Medal of Science. Numerous faculty members have been honored with professional distinctions and awards in fields as disparate as archaeology and astronomy or ophthalmology and urology. This distribution of excellence runs through all the customary academic divisions.

ASU is proud of having its first Pulitzer Prize winner (Poetry) and its first MacArthur Foundation Fellow designated in the past year. A second MacArthur Fellow has just been announced. The number of Fulbright grantees has averaged about six each year since 1984, but the number of NSF Presidential Young Investigator awards since 1984 stands at 11. The majority of these PYI awards have gone to younger faculty in Engineering, demonstrating the effectiveness of purposeful recruiting under the provision of Engineering Excellence. The number of Guggenheim awards at ASU has not matched that of UA, but in one small unit, the Creative Writing Program of the Department of English, 6 full-time faculty have garnered 5 Guggenheim awards, evidence again of purposeful and effective recruiting. Three have received Kellogg Foundation Awards, and one a Humboldt Foundation Senior Scientist Award, and one a USSR National Academy of Sciences Medal. Two ASU faculty have received National Institute of Health Career Development Awards, and for 1988-89 two ASU faculty have received appointments to the National Humanities Center in North Carolina. Apart from Duke and the University of North Carolina, both part of the Research Triangle triumvirate, Harvard and ASU are the only universities with more than one representative among the 35 fellows.

During the past five years NAU faculty have received 14 Fulbrights and numerous professional society awards. Two have received National Endowment for the Humanities fellowships. Others have had a Mellon Fellowship, a Danforth Foundation Fellowship, a National Geographic Fellowship, and fellowships from the Clark memorial Library and the Institute National des Etudes Demographiques in Paris.

Such accomplishments as these establish an institution's reputation for excellence, although they may not establish the excellence of its basic instructional programs. In the case of graduate programs, an institution's reputation for excellence can be influenced by the success of its graduates, how effectively they compete with graduates of other programs and what recognition they achieve in their professional careers. But attempts to formulate reputational rankings have not been fully satisfactory. Too often they measure an institution's or a program's renown, invoke vague or impressionistic comparisons, or reinforce an assumed pecking order.

The last, concerted attempt to rank the quality of graduate programs was conducted by the National Research Council in 1981-82. Respondents were asked to assess four aspects of graduate programs in their own disciplinary areas in a number of major universities:

(1) faculty quality,

(2) effectiveness in educating research scholars,

(3) improvement in the last five years, and

(4) familiarity to the evaluators. Only those programs which produced a specified number of research doctorates during a specified span of years were included for evaluation.

No NAU programs were rated, and UA understandably had more disciplines included than did ASU. The resultant rankings are by now obviously outdated, but for the two larger Arizona universities they were problematical even then. Both universities are characterized by the rapidity of their recent growth and consequently rated much higher in the "Improvement" column than in the "Familiarity" column. Even so, both institutions had at least six identifiably strong graduate programs. Were a similar attempt to rate graduate programs undertaken today, both UA and ASU would present some distinctly higher program profiles.

According to graduate deans at the three universities, there is little incidence of losing faculty to more competitive institutions. From department heads and center directors, the message changes a bit: the universities will in most cases take active steps to retain valued personnel but have lost promising and productive faculty, especially in areas where salaries for some tenured positions are not covered by state funds but have to be covered out of grant funds or indirect cost recovery funds. Regents' professorships might help in some instances to keep a highly talented individual from moving, but they are not intended nor can they serve as bargaining chips to keep a star from straying. Warm winters alone will not serve to build or to retain a research active faculty, nor will a merely palliative policy of merit pay. Working conditions that include adequate space, necessary equipment, and library resources, as well as the presence of able students, helpful staff, and efficient administrators, can be as important as monetary reward.

The cost of being competitive in attracting new faculty will vary greatly even when salaries do not. The start-up costs for a promising young researcher may be several times the basic salary. The cost of attracting a major researcher with current sponsored projects seems

beyond the reach of even most of the hot science areas. Endowed chairs are a rarity in Arizona's universities and no one has yet begun to campaign openly to initiate an eminent scholars' program, such as Ohio has, to build rapidly in areas of most significant current importance and greatest potential economic impact.

Both UA and ASU have been strikingly competitive in building major research libraries, but the past year has introduced some dissonant notes. First, the good news: The Association of Research Libraries has provided an analysis of library holdings and staff resources that shows UA in 19th place and ASU in 27th place for 1986-87. The rating is based not only on the number of volumes held (UA: 3,239,055; ASU: 2,215,376), but also on the number of volumes added, the number of current serials received, the total expenditures, and the number of professional plus nonprofessional staff. These were highly competitive positions in the rating system and they constitute an area of excellence in both universities, an area recognized and highly valued by faculty.

The bad news, however, is that none of the three universities received an increase in their acquisitions budget for 1987-88, not UA and ASU, which fear a decline in the ARL ratings, and not NAU, which needs badly to improve its holdings and its staffing. ASU needs a 12% increase in its acquisitions budget for 1988-89 just to maintain its present level of book purchases and journal subscriptions. The UA library is in its second year of reducing journal subscriptions by $100,000 a year. Even if the cuts are made judiciously, they will slow the advance and diminish the excellence of a remarkably fine research facility. The diminished value of the dollar in foreign markets and the increased cost of foreign books and periodicals (as much as 60% in one year) have been particularly troublesome. At ASU a $90,000 contribution from the budgets of the academic deans and a $225,000 infusion of indirect cost recovery funds from the Vice President for Research have forestalled current cuts, but the library director estimates that he will need at least a 7% increase in the acquisitions budget if he is to avert reduction of journal subscriptions in 1988-89.

A further problem for the research dimension at the ASU library is that acquisitions for the next few years will have to include volumes purchased for ASU West, virtually all of them duplicating titles held in Tempe. At this stage such use of financial resources to buy duplicates is essential for the academic viability of ASU West, but it comes at the cost of research resources at the Tempe campus.

## INCREASING NON-STATE FUNDING FOR RESEARCH

Each university would like to draw more funding from non-state sources, especially in what promises to be a dry year, but there are no easy answers or painless fiscal remedies. After several years of growing deficits, federal R & D funds are not likely to increase. Competition for what is available will be especially keen, and from recent announcements priority emphasis will fall on the kind of research characteristic of interdisciplinary research centers engaged in large-scale team research, rather than on individual research projects. The route to increased non-state funding for research lies through judicious state investment in:

(1) units with demonstrated and effective economic leverage,

(2) the creation of new units in areas of demonstrable research importance, and

(3) the strengthening of existing units in areas of high potential funding.

Such a policy need not ignore or neglect areas of social, cultural, or artistic importance; nor need it create an imbalance between instruction, service, and research responsibilities. It should, however, influence strategic planning, help establish priorities for policy and program changes, and move Arizona's universities into positions of greater prominence through focused attention to measures of research and instructional excellence.

An example of support for an established unit with demonstrated excellence and effectiveness could lie in the current request of the Optical Sciences Center at UA to fund a center for Optical Computing and Optical Data Storage. Over a 20 year period the Optical Sciences Center has received nearly $10 million in state funds and generated nearly $90 million from federal and corporate sponsors. During the past year state investment of $1 million produced a cash flow of $10 million. Four corporate sponsors have already committed $250,000 each for the proposed Optical Data Storage Center, and the scientific need is so great that the state investment cannot fail to produce a manifold return. Outside funding has already given the UA and the state a much finer facility than the state could possibly afford. It is a genuinely national scientific resource and a highly envied example of educationally constructive economic leverage. If Solid State Science and Solid State Electronics at ASU could follow the same pattern, similar institutional and community benefits would result.

An example of a new unit created to meet important new needs is too much an imaginative indulgence at this stage, but such examples would certainly follow if the supercollider were to come to Arizona. The strengthening of existing units in areas of high potential but currently underutilized funding is the most prevalent strategy for increasing non-state research support. ASU's Engineering Excellence program, about to enter its third phase, is perhaps the best example of strengthening a broad band of applied science and technology programs and making them competitive with those of leading research institutions. Engineering currently draws more than one-third of ASU's non-state research funding, and this proportion is likely to increase as Engineering Excellence moves into its third and continues to plan for its fourth phase.

At UA a proposed expansion of Materials Science in both research and instruction builds on an existing area in ways that could significantly transform it, modernize its past focus, and effectively reinforce initiatives in Electrical Engineering, Optical Sciences, Surface Science, and Chemistry. The proposal could lay the basis not only for external funding but for the commercialization of processes and products in electronics and opto-electronics and for student familiarization with equipment not presently available. Such a strategy of strengthening existing units so as to create a new entity with larger research potential is evident also in the reorganization of biology emphases and the focus on insect science that has brought a new NSF Biology Center to

Tucson.

The quality of ASU's life sciences faculty, the availability of funding in this area, and the fact that life sciences currently draw less than 10% of the university's external research support (when more than half of the federal R & D budget goes to the life and health sciences) all suggest the underutilization of faculty resources and research potentialities in this area. But the specter of duplication already affects the further development of what is indisputably an area of strength. The shortage of lab space is a grievous obstacle and a major disincentive. Planning with foresight, investment in needed facilities, and effective recruiting could significantly raise research grant applications and awards. The same strategy, drawing upon resources in Bioengineering, could attract biotechnology (including genetic engineering) firms to the underutilized space in the ASU Research Park. In fact strong life science units exist at all three universities and the faculties have demonstrated research excellence. The problem of duplication might be one of triplication unless each university focuses on distinct areas of life science research.

If NAU were intent on increasing non-state funding for research, the best strategy would seem to lie in emphasizing areas of regional importance and institutional strengths: quaternary studies, forestry and ecology, cultural and economic issues of American Indians, and current problems in education.

**CONCLUSIONS**

There is no reasonable likelihood that anyone would consider duplicating the most expensive and extensive research facilities, such as the College of Medicine, the Optical Sciences Center, the Steward Observatory, at any location other than their present one at UA. But the inseparable relationship of university research to graduate education, the considerable impact of non-state research funding on the local economy, and the importance of university research, instructional, and cultural resources as a magnet for new industry obviates much of the argument against duplication. More would be lost than could possibly be gained by concentrating teacher education on one campus, life sciences on another, engineering on a third, and so on.

To a great extent, the research accomplishments of the faculty at UA have given us an internationally recognized institution. The growth of programs and the many individual contributions to an enlarged sense of mission at ASU have produced a rate of productivity and improvement unlikely to be matched. The emergence of NAU as a comprehensive university extends educational opportunities and alternatives and serves a population that might otherwise be neglected.

Because of its historical emphasis on research, the UA is a far better university than the State of Arizona could otherwise afford; because of the constructive transformation of ASU many diverse needs of the state's population center are being better met; and because NAU can still emphasize undergraduate education its students can gain some of the advantages of smaller scale and educational intimacy.

## RECOMMENDATIONS

- The Board of Regents and the Executive and Legislative Branches of state government should increase support of basic and applied research, scholarship, and creative activity in the three universities as a sound investment in the future of the state.

- The Board of Regents, university administrators, and individual faculty should do a better job of articulating the role of university research in (1) the expansion and promotion of knowledge, (2) the education of students at the graduate and undergraduate level, (3) the recruitment and retention of creative and productive faculty, (4) the competition for external support, and (5) the stimulation of economic growth and competitiveness of Arizona and the nation.

- As part of the strategic planning process, the Regents and the universities should seek to develop the research function of each institution so as (1) to further the institutions' stated mission, (2) to build on demonstrable strengths, (3) to maximize the possibility of external funding, and (4) to provide for state and regional needs.

- The Regents should continue to encourage each institution to develop flexible polices of assignment and evaluation keyed to an individual's specific strengths rather than to a uniform pattern. In recognition of the stated role of teaching and research in each institution's mission, the criteria for evaluation and determination of merit should reward strong contributions to all facets of the institutional mission.

- Each institution should listen to what faculty cite as research disincentives and seek remedies insofar as possible. Among these disincentives: the library at NAU, the level of support for the arts and humanities in each institution, the shortage of lab space and the state of equipment at UA and ASU, the need for state-provided seed money and matching funds, bureaucratic procedures that require the expenditure of more time in preparation and evaluation of mini-grant applications than the amount warrants, and the glaring inequities in distribution of travel funds between units and between administration and faculty.

- Each institution should maintain the strong incentives: The high quality of the UA and ASU libraries, locally administered grants-in-aid available on a timely basis, and the admirably effective Distinguished Research Awards initiated at ASU and worthy of consideration elsewhere.

- The Regents should consider starting an eminent scholars' program to attract highly productive researchers in areas of strategic importance.

- Each university in its strategic planning should develop specific proposals for increasing non-state funding for research, building on present strengths, on areas of increasing research importance, and on the likelihood of high potential funding.

## APPENDIX

1. Questionnaire Sent to Graduate Deans and Vice Presidents for Research

2. Questionnaire Sent to Selected Department Heads

## GRADUATE DEANS AND VICE PRESIDENTS FOR RESEARCH

### Questionnaire Research and Graduate Education Part 1

1. Define or describe the role of research efforts in the present and future plans of your institution. Include any reports or documents relative to this topic completed in the past five years.

2. Describe current dollar levels and sources of funding for research activities.

a. What are the current sources of research funds? List specific amounts for the past fiscal year and the specific sources of grants and contracts for the same period.

b. What range or variety of projects, programs, or equipment purchase is supported by externally funded research? By indirect costs recovered from sponsored research?

c. What is your procedure for recovery of indirect costs or overhead and for distribution of these funds?

3. How have the dollar totals for grants and contracts changed in the last ten years? In the last twenty years?

4. In view of the fact that research activities have been criticized on grounds that they detract from the instructional role of the institution and its faculty, state your views of the relationship between research and teaching at your institution. Consider the effect of research on undergraduate education and its role as a component of graduate education.

5. Approximately what portion of total tenured or tenure-track faculty time in each of the colleges or schools is devoted to research? How much staff time? How much student time?

a. in the case of externally sponsored projects?

b. in the case of internally sponsored projects, including centers or institutes?

c. in the case of unsponsored, individual faculty research?

6. What incentives currently exist to encourage research and creative scholarship?

a. What additional incentives seem to you to have potential benefit?

b. Are there significant disincentives?

7. What are the expectations of research/scholarship in faculty personnel decisions?

a. for promotion to associate professor and tenure?

b. for promotion to professor?

c. for performance evaluation and salary adjustments?

8. What constitutes accurate and appropriate measure of the quality of research and creative scholarship in the various fields represented on your campus?

9. What do you consider a desirable balance between State investment in research (both organized and departmental) and in instruction in your institution? What are the salient factors supporting this judgment?

10. What are your highest priorities for assigning funds?

a. Is the system of decision packages appropriate or effective in identifying priorities?

b. Is the ranking process effective?

c. What follow-up measures help assure accountability?

11. How can funding for research from non-state sources be increased?

a. from corporate sources?

b. from alumni sources?

c. from foundations and institutes?

12. Is there institutional benefit derived from faculty participation in professional service, such as service on NSF panels, evaluation of NEH or NEA proposals, or Fulbright-Hays screening committees? Please explain.

13. How competitive is your institution in attracting and retaining high quality, productive research scholars? How do you measure this sort of competitiveness?

14. From your perspective and experience, how do the quality and quantity of research, including research carried out by graduate students, affect the economic climate or development of Arizona? Can you provide examples of research from your campus that may have directly benefited the economy of the State?

15. Please add any comment on the subject of research not adequately elicited by the preceding questions.

**Questionnaire Research and Graduate Education Part II**

16. Do you have any data that demonstrate a relationship between the strength of research programs or areas and the recruitment of highly qualified and professionally promising graduate students?

17. Does evidence exist to demonstrate that the State benefits from recruitment of superior graduate students? Consider long-range as well as immediate benefits.

18. Is there a point at which the enrollment of a graduate program or subdiscipline is too low to provide sufficient student interaction and to warrant continuation?

a. What level of degree production might sound such a warning?

b. What criteria other than degree production help determine the viability of a graduate program?

19. What measures are used to assess and to raise the quality of graduate education?

20. Describe how the number and diversity of graduate programs have changed during the past decade.

a. List the masters' programs and the doctoral programs that existed in 1977.

b. Indicate the introduction of new graduate programs or the elimination of obsolete programs by year through 1987.

c. Indicate plans for new programs or significant changes in existing programs.

21. Describe the quality of graduate and professional programs by reference to bona fide national rankings. You may use approximations such as top ¼, second ¼, etc.

22. Describe the quality of students' admitted in terms of their performance on the GRE or other professional test scores. Are we attracting good students in adequate numbers?

23. Can you provide information about graduate students in your programs?

a. Where do they come from?

b. Why do they apply to your institution?

c. Why do some students who have been admitted choose to go elsewhere?

24. Do you have information on your graduates in their post-graduate careers? Where do they go?

25. What incentives exist to encourage high quality graduate teaching and graduate student supervision?

26. How adequate is the support for graduate students? Cite amounts available and individual stipends for:

a. Scholarships.

b. Fellowships.

c. Graduate Teaching Assistantships and Associateships.

d. Graduate Research Assistantships and Associateships.

e. Tuition waivers.

27. Identify sources of financial support for graduate students in the above categories and for such additional categories as travel, individual research projects (may include support from faculty grants and contracts or support from companies or government agencies that goes directly to the student).

28. Comment on the quality of advising and supervision, on the provision of office space, computer or laboratory support, and travel funds for graduate students.

29. What quality-control requirements exist in areas of research or performance for graduate and professional degrees?

30. Please add any comment on the subject of graduate education not adequately elicited by the preceding questions.

**Questions for Department Heads and Faculty of Selected Departments**

1. Describe the role of research efforts in the present and future plans of your department.

2. What are the chief sources of research funding in your area?

a. Do these sources meet faculty needs?

b. How would you characterize the role of the administration in aiding your access to research funding? At the college level? At the university level?

c. Could it be improved?

d. How can funding from non-state sources be increased?

e. How do you share in overhead-return funds?

3. How has the research profile of your department changed in the last five years? The last ten years?

4. How has your department been ranked in national surveys?

5. Do you agree with the rankings?

6. What are your views on the relationship between research and teaching, with reference to your department?

a. At the undergraduate level?

b. At the graduate level?

7. How would you define a "research-active" faculty member?

8. What percentage of your faculty do you consider to be research-active?

9. How much time do you expect a research active faculty member to devote to research? To teaching?

10. What do you think of the following research incentives created by the university?

a. Regents' and Distinguished Professorships?

b. Grants-in-aid?

c. Other?

11. What are your requirements of research/scholarship in faculty personnel decisions?

a. For promotion to associate professor and tenure?

b. For promotion to professor?

c. For performance evaluation and salary adjustment?

12. How do you evaluate the quality of research and publication in your unit?

13. Do you have a Gifts and Grants account or any other local discretionary account?

a. What is it used for most frequently?

b. Do you actively solicit contributions to this fund? How?

14. How much is available in your unit for travel to professional meetings? (Do not include travel covered by grants.)

a. How much per capita?

b. Is this adequate?

c. How important is it for faculty to travel to meetings?

15. Summarize your policy for distributing travel funds.

16. How do you initiate decision package requests in your unit?

a. Is the decision-package system appropriate and effective in identifying priorities?

b. Does the system inform you about the status or ranking of your request and the reasons for that ranking?

17. Can you overcome problems of equipment obsolescence by means of current capital equipment allocations?

18. Does the current university capital equipment expenditure for your unit improve or hinder your research effort?

19. How effective have your recent efforts been at recruiting research-oriented faculty?

20. In recent years have you lost any faculty that you tried to retain?

21. Can you describe any social, cultural, or economic benefits to Arizona from research, publication, or performance that originates in your unit?

22. Does your unit attract highly qualified graduate students because of its programs or personnel?

a. Where do they come from?

b. Why do some students who have been admitted choose to go elsewhere?

23. Do you limit graduate admission by means other than customary criteria?

24. What are your criteria for admission of master's students? Doctoral students?

25. Overall, how competitive are Arizona university undergraduates who apply for admission to your graduate programs? What percentage do you reject?

26. How do Arizona university B.A. and B.S. graduates who are admitted to your graduate programs perform in comparison to graduates of other universities who are in your graduate programs?

27. Are you competitive with peer units or institutions in support for graduate students?

a. Scholarships and fellowships?

b. Teaching assistantships?

c. Research assistantships?

d. Tuition waivers?

e. Support from non-state sources?

f. Laboratory or office space?

g. Computer facilities?

28. What could the university do to strengthen your graduate program and make your graduates more competitive?

29. Have you introduced any new graduate programs since 1977? Do you plan to initiate any?

30. How well do your graduates do in their post-graduate careers? Where do they go?

31. How does your department recognize, value, or encourage high quality graduate teaching and graduate student supervision?

32. How do new faculty become familiar with departmental and graduate college requirements and learn to direct theses and dissertations effectively?

33. Are you satisfied with the quality of dissertations completed in your unit? Can you suggest any means of improvement?

34. Please attach a copy of your 1986-87 annual report to this completed questionnaire.

## ENDNOTES

1. Almost as much in state support went for the Agricultural Experiment Station, which is budgeted separately from Organized Research.

2. These variables include federal R & D expenditures, library holdings, state and local R & D expenditures, R & D expenditures from industrial sources, R & D expenditures from institutional sources, number of full-time scientists and engineers, number of part-time scientists and engineers, number of other doctoral research personnel, number of full-time science and engineering graduate students, number of PhD's awarded in all fields, number of post-doctoral science and engineering students, total capital expenditures for R & D from all sources and total expenditures for R & D equipment from all sources.